

MORTALITY AND ANTHROPOGENIC HARASSMENT OF HUMPBACK WHALES ALONG THE PACIFIC COAST OF COLOMBIA

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Reports of humpback whale, *Megaptera novaeangliae*, mortality and harassment in Pacific waters of Colombia from 1986-2000 were analysed to determine annual frequency, location, month of occurrence, age class and potential cause. Of the 24 records, 4 were published reports and 20 collected by the authors. Significantly more animals were found dead or entangled during the 1996-2000 period ($n = 18$), than previous years 1986-1990 and 1991-95 ($n = 6$). Of all deaths and harassments 54.2% were calves, 41.7% adults and 4.2% juveniles, with the number of calves being significantly high, considering that the calf vs adult population ratio was consistent with 3:7 hypotheses. Deaths/harassments were more common in the Negritos Banks area (54%), followed by the Gorgona-mainland (21%), Bahía Solano-Utria sound (12.5%) and other areas (12.5%). Greatest incidence (87.5%) was in the second half of the year: August ($n = 6$), September ($n = 5$) and October ($n = 6$). Two calf strandings were recorded early in the year, one in February and one in April and probably originated from the Northern Hemisphere population. Annual frequency of occurrence over the 15-year period indicates an increasing trend of entanglement and vessel strike since 1996. For 24 reported events the cause of death was unknown in 9 and of the remaining 15, 1 was from natural causes with 14 showing signs of anthropogenic influence: 10 entangled, 3 from vessel strike and 1 exhibiting marks consistent with a hunting attempt. □ Colombia, humpback whale, harassment, death, entanglement, vessel strike.

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Cetacean research in Colombia is recent compared with other South American countries (Vidal, 1990; Flórez-González & Capella, 1995). There are no records of strandings or bycatches of great whales prior to the early 1970s (Vidal, 1990; Fundación Yubarta, unpubl. data), but some general commercial whaling data exist from the tropical eastern Pacific. Between the 18th and 19th Centuries, American whalers hunted sperm (*Physeter macrocephalus*) and baleen whales, mainly humpback whales (*Megaptera novaeangliae*), largely from the Galapagos Islands and in the Panamá Bay Bank, along a deep-water belt from the coast of Darién in Colombia to the Gulf of Chiriquí in Panamá (Townsend, 1935). Information from the Pacific coast of Colombia is sparse with sightings of humpback whales first mentioned by Brown (1905), and subsequently by Clarke (1962), Alberico (1986) and Flórez-González (1989).

Humpback whales, world-wide, migrate annually from high latitude, cold-water feeding grounds to tropical waters for breeding and calving (Mackintosh, 1965; Dawbin, 1966; Clapham & Mead, 1999). Distribution and

migratory movements of humpback whales in the western seas of South America are known from whaling records, occasional sightings and recently from the identification of individual animals (Townsend, 1935; Mackintosh, 1965; Aguayo, 1974; Flórez-González, 1989; Stone et al., 1990; Gibbons et al., 1998). Humpback whales feed along the western Antarctic Peninsula during summer of the Southern Hemisphere (Stone & Hamner, 1988; Stone et al., 1990) and in winter migrate to breeding grounds along the coast of Colombia and Ecuador (Flórez-González et al., 1998).

Annually, from June - November, humpback whales visit the near-shore waters of the Colombian Pacific for rearing of calves and breeding (Flórez-González, 1991; Flórez-González & Capella, 1993). Sightings in oceanic waters are rare during the breeding season (Wade & Gerrodette, 1993; Gerrodette & Palacios, 1996). Although humpback whales are distributed and migrate close to continental shores (Flórez-González et al., 1998), records of strandings and entanglements are uncommon in Colombia. Prior to 1986 no data were available,

but in recently considerable numbers have been documented along Colombia's Pacific coast. In this paper, we review the limited published records and other information on deaths and entanglements of humpback whales to determine annual frequency, spatial distribution and age classes involved. Apparent causes of mortality and harassment of whales were also examined.

METHODS

STUDY AREA. The study covered beaches and near-shore waters along the Pacific coast of Colombia, extending to the borders of Ecuador and Panamá (DIMAR, 1988), and waters surrounding the offshore islands of Gorgona (02°58'N, 78°11'W) and Malpelo (03°58'N, 81°35'W) (Fig. 1).

DATA COLLECTION. Data of deaths (stranding, floating dead or osteological remains) and entanglements were obtained by Fundación Yubarta researchers, mainly during fieldwork of an ongoing study, from 1986. Information provided by locals was confirmed and augmented, in some cases involving travel to specific sites and in other cases analyses of photographs, videotapes or written reports. Mostly the 'cause' of death was established by observation of the carcass and not from necropsy. Available literature was also reviewed for records of strandings and osteological remains.

ANALYSES. The following data were recorded for each dead, entangled or otherwise harassed whale (i.e. with traces of nets on body from recent non-lethal entanglement): date, location, body length (or estimate), gender (if known), estimated age class and the presence of body markings or net remains indicating possible anthropogenic cause. Years are not listed where no deaths or entanglements were reported. Where body length was not recorded, report notes and other published parameters taken from whale catch data were used to infer the age class. Animals <8.0m in length were defined as 'calf' and presumed to be a calf of the year (Chittleborough, 1959; Nishiwaki, 1959; Clapham & Mead, 1999). Whales measuring between 8.0-12.0m were classed as 'juvenile' (Nishiwaki, 1959; Clapham, 1992, 1994) and animals >12.0m as 'adult' and considered to be sexually mature (Nishiwaki, 1959; Rice, 1963; Clapham, 1992).

Two seasons, summer and winter, are distinguished here: 'summer' is considered as January to June (corresponding to the summer and



FIG. 1. Map of Pacific coast of Colombia showing the locations (solid dots) of the reported cases of death and harassment (by entanglement) of humpback whales from 1986-2000.

autumn seasons in the Southern Hemisphere) and 'winter' as July to December (winter and spring).

Factors relating to mortality or harassment were obtained from on-site examination by investigators of Fundación Yubarta, or from written reports or photographs. Where on-site records made reference to net fragments on the body, rope marks, large cuts, propeller marks or broken bones, we attributed the death or harassment event to possible anthropogenic causes (entanglement, ship strike or possible intended hunting). Deaths that showed no indication of human interaction were grouped into a category of 'natural' death (Wiley et al., 1995). Osteological remains or carcasses reported in an advanced stage of decomposition were considered as 'unknown' cause of death.

RESULTS

Data on 24 cases of death or harassment of humpback whales were gathered between 1986-2000 (Table 1). Four were reported by Mora & Muñoz (1994), the first Colombian record consisting of osteological remains of an adult in 1986. Of the incidents recorded, 75% (18/24) occurred from 1996 onwards, while only three were reported during each of the periods 1986-90

and 1991-95. Due to the small size of the sample, statistical analyses should be regarded with caution even when significant differences appear. The number of dead and entangled whales was significantly greater in the period between 1996-2000 ($n = 18$), than the 1986-90 (Mann-Whitney, $U = 25.0$, $P < 0.01$), 1991-95 (Mann-Whitney, $U = 25.0$, $P < 0.01$) and 1986-1995 (Mann-Whitney, $U = 50.0$, $P < 0.001$) periods pooled together ($n = 6$). Although there were two 2-year periods of no reported incidents (1988-89 and 1994-95), the annual frequency of occurrence over the 15-year period indicates an increased trend of entanglement and death since 1996.

Three incidents were not included in the monthly occurrence analysis (Nos 1, 3 and 6, Table 1), these being osteological remains or of mummified bodies, which prevented determination of the date of death to the month level. There were significantly more deaths and entanglements (90.5%) during winter (second half of the year) with only two cases (9.5%) during summer (Fig. 2) (Mann-Whitney, $U = 36.0$, $P < 0.005$). Greatest frequencies were in August ($n = 6$) and October ($n = 6$) followed by September ($n = 5$), accounting for 80.9% of all incidents.

Based on the inferred age classes, 54.2% ($n = 13$) were calves of the year, 41.7% ($n = 10$) adults and 4.2% ($n = 1$) juveniles (Table 1). Pooled yearly data showed the number of deaths and entanglements of calves and adults was not significantly different from parity (G -statistic, $G = -31.492$, $P > 0.9$). When compared with the 3:7 (calves vs adults) hypothesis (the highest ratio found within the Colombian Pacific breeding sites [Bravo et al., 1994; Celis, 1995; Flórez-González et al., 1997]), a real age class ratio showed the number of dead and entangled calves was significantly larger than that of adults during the study period (G -statistic, $G = 6.944$, $P < 0.01$). Since 1996, 66.7% ($n = 12$) of the 18 incidents documented involved calves. Gender information was available only for five whales; four female and one male.

The greatest incidence of death and/or entanglement occurred in Negritos Banks and surrounding area (Fig. 1) with 13 cases (54%), followed by 5 in the Gorgona Island-mainland area (21%), 3 in the Bahía Solano-Utría Sound area (12.5%) and others (12.5%). Of the 24 reported cases, 10 were entanglements, of which 2 drowned and 8 had unknown outcomes. Three of the entangled whales with unknown outcomes

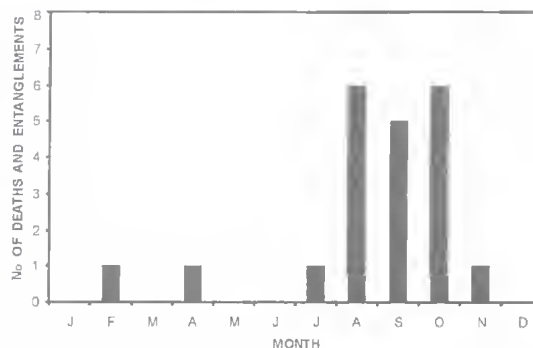


FIG. 2. Number of deaths and entanglements of humpback whales per month reported along the Pacific coast of Colombia, 1986-2000.

were released alive or partially disentangled after human intervention (Table 1). Of the 24 animals documented, 9 were eliminated from analysis of potential cause of death: 3 being osteological remains and 6 in partial or advanced stage of decomposition. Of the remaining 15, 3 (20.0%) had injuries potentially attributed to vessel strikes, 10 (66.7%) were entangled, 1 (6.7%) exhibited marks consistent with hunting attempts and 1 (6.7%) died of natural causes. Thus, 93.3% of the sufficiently inspected whales showed signs that anthropogenic factors may have contributed to, or have been directly responsible for, the death or harassment (and potential death).

DISCUSSION

The results indicate that deaths and harassments of humpback whales along the Pacific Colombian coast have increased since 1986, principally between 1996-2000 (75%). It is likely that the actual incidence of death and entanglement (directly lethal or not) could be higher, since not all dead humpback whales wash ashore, nor are live disentangled whales always observed (as evidenced by whales with pieces of net attached). Possible explanations for the apparent increase in deaths and entanglements include the growth of the humpback whale population, increase in mortality factors and in observation efforts. This last factor seems unlikely as the authors obtained the majority of records during a long-term study on breeding of humpback whales begun in 1986 and fieldwork effort has been equal from year to year. If the reported increase in deaths and entanglements were due to increased observer effort, an increased incidence of these events for other great whales should also be expected. However strandings or entanglements of sperm whales and Bryde's whales (*Balaenoptera edeni*)

TABLE 1. Records of deaths and harassments of humpback whales along the Pacific coast of Colombia, 1986-2000.

No.	Date	Locality	Position	Age class	Length (m)	Sex	Remarks, Carcass Analyses	Cause of death or harassment	Source
1	23.08.86	Cuevita bay	05°24'N 77°25'W	Adult	-	?	Osteological remains	Unknown	Mora & Muñoz (1994)
2	.09.87	Malpelo island	03°56'N 81°34'W	Juvenile	~10	?	Floating dead, with marks of harpoon	Hunt	This study
3	23.12.90	Usagará	04°50'N 77°22'W	Adult	-	?	Osteological remains	Unknown	Mora & Muñoz (1994)
4	.09.92	Puerto España	04°00'N 77°25'W	Adult	-	?	Stranded dead. No external injuries noted	Natural	Mora & Muñoz (1994)
5	15.02.93	Bahía Solano	06°15'N 77°25'W	Calf	3.5-4.0	?	Floating dead, partially decomposed	Unknown	This study
6	.06.93	Salahonda	02°05'N 78°42'W	Adult	-	?	Osteological remains	Unknown	Mora & Muñoz (1994)
7	.08.96	Negritos Banks	03°55'N 77°25'W	Calf	~6	?	Disentangled alive from gillnet	Entanglement	This study
8	11.08.96	Negritos Banks	03°55'N 77°25'W	Adult	~16	?	Alive with net around mouth, survival unknown	Entanglement	This study
9	.09.96	Gorgona island	03°00'N 78°12'W	Calf	~7	♂	Floating dead, partially decomposed	Unknown	This study
10	19.10.96	Negritos Banks	03°55'N 77°25'W	Adult	16	♀	Alive with net around mouth, survival unknown	Entanglement	This study
11	19.10.96	Negritos Banks	03°55'N 77°25'W	Calf	6	?	Alive with net around mouth, survival unknown	Entanglement	This study
12	14.07.97	Chicoperez	02°50'N 78°22'W	Calf	6	♀	Dead in a gillnet	Entanglement	This study
13	.08.97	near Gorgona Is	03°05'N 78°20'W	Calf	~6	?	Disentangled alive from purse seine	Entanglement	This study
14	.09.97	Charambirá	04°17'N 77°30'W	Adult	>13	?	Stranded dead, partially decomposed	Unknown	This study
15	28.10.97	Ladrilleros	03°56'N 77°22'W	Calf	5.2	♀	Stranded dead. Two areas of hemorrhage noted	Vessel strike	This study
16	21.04.98	Utria Sound	06°05'N 77°22'W	Calf	~5	?	Stranded dead. Propeller cuts on caudal peduncle	Vessel strike	This study
17	02.10.98	Del Tigre Sound	03°52'N 77°18'W	Calf	~7	?	Floating dead. Advanced decomposition	Unknown	This study
18	15.11.98	Del Tigre Sound	03°52'N 77°18'W	Calf	6	?	Floating dead, partially decomposed	Unknown	This study
19	17.08.99	Charambirá	04°17'N 77°30'W	Adult	>13	?	Stranded dead, partially decomposed	Unknown	This study
20	20.08.99	Piangüita	03°50'N 77°10'W	Adult	16.5	♀	Stranded dead. Right mandible fractured, cuts on peduncle	Vessel strike	This study
21	04.10.99	Utria Sound	06°05'N 77°22'W	Calf	5	?	Dead in a gillnet	Entanglement	This study
22	22.08.00	Negritos Banks	03°55'N 77°25'W	Calf	6	?	Alive with net around head, survival unknown	Entanglement	This study
23	30.09.00	Mulatos	02°40'N 77°25'W	Adult	>13	?	Disentangled alive from gillnet	Entanglement	This study
24	15.10.00	Negritos Banks	03°55'N 77°25'W	Calf	~5	?	Alive with net around mouth, survival unknown	Entanglement	This study

have remained relatively constant and low in Colombia for the same period (Fundación Yubarta, unpubl. data).

Increase in deaths and entanglements may be due to an increase in the number of animals inhabiting the study area, or an increase in human

activity (i.e. vessel traffic, expansion of gillnet and purse seine use), or both. Recent humpback whale estimates show a significant increase in the population wintering in Colombian waters during the decade 1986-95, from a mean size of 173 (Flórez-González, 1991) to 1,495 (Capella et

al., 1998), an increase of 764%. Although the population size estimated for both the Negritos Banks (mean 857, 95% CI 547-1167) and Gorgona Island area (mean 1495, 95% CI 919-2071) is not different (Capella et al., 1998), greater densities are also typically found in the Negritos Banks area as compared with other breeding sites on the Pacific coast of Colombia (Flórez-González et al., 1997). The annual frequency of deaths and entanglements rose sharply in 1996, with no evidence before then. The highest frequency occurred in the surrounding waters of the Negritos Banks on the central coast of Colombia. Notably, 61.5% (8/13) of the deaths and entanglements reported since 1996 in this area were related to human activity, including vessel strike and entrapment in gillnets or active fishing gear. These factors represent an increased hazard to animals seasonally inhabiting this area. The Buenaventura harbour, a few kilometers south of Negritos Banks, is the main fishery and commercial shipping port on the Colombian Pacific coast. Artisanal gillnet fishing is important in the coastal waters around the Bahía Málaga and Negritos Banks (pers. obs.), as is a growing commercial traffic of whale watching vessels that commenced in 1994 (Pardo, 2000; Fundación Yubarta, unpubl. data).

Monthly distribution of humpback whale deaths and entanglements was not restricted to the second half of each year, although it was most frequent from August-October (Southern Hemisphere winter), when the species occupancy reaches peak levels in near-shore waters of the Colombian Pacific (Flórez-González & Capella, 1993; Soler, 1996; Suárez, 2000). One early calf death was reported in February and one in April, (winter months of the Northern Hemisphere). These two calves were found on the north coast of Colombia and probably belonged to the North Pacific humpback whale population that breeds from Mexico to Costa Rica (Urbán & Aguayo, 1987; Steiger et al., 1991; Rasmusen et al., 1995). Few sightings of humpback whales have been reported for the northern coast of Colombia during the first half of the year (Fundación Yubarta, unpubl. data). These records are consistent with findings from genetic studies (Baker et al., 1990, 1998) and support consideration of this region as a potential site for exchange between hemispheres (Flórez-González et al., 1998).

Since humpback whales are more commonly found in coastal waters (Flórez-González, 1991; Flórez-González & Capella, 1993), they are more exposed to vessel traffic and various types of

fishing gear. Although the cause of death in 9 (37.5%) reported cases was not determined, a significant portion (58.3%) of deaths or harassments were related to human factors, principally vessel strike and entanglement as gillnet bycatch. About 3% of humpback whales identified in Colombian waters show holes, scars, or deep cuts on the body, evidence from ship strikes and propeller cuts without immediate lethal consequences (Fundación Yubarta, unpubl. catalogue). Our results are consistent with research in other humpback whale breeding and feeding grounds which frequently implicate human-related activities (mostly bycatch entrapments) to whale deaths (Wiley et al., 1995; Félix et al., 1997; Mazzuca et al., 1998; Weinrich, 1999) and that fishing gear entanglements are a highly significant threat (Perkins & Beamish, 1979; Heyning & Lewis, 1990; NMFS, 1991; Perrin et al., 1994).

Recent reports of humpback whale deaths and entanglements are disproportionately high for calves of the year, indicating that this portion of the population should be an important focus for management in Colombia and the southeast Pacific. Although the cause of death of some stranded whales could not be certain, activities such as irresponsible whale watching may have contributed to mortality. Calves have been temporarily separated from their mothers through harassment from whale watching vessels (pers. obs.) and such 'disorientated' calves, or newly weaned calves, may be susceptible to entanglement in nearby nets. Information on calf mortality is a critical parameter to determine recruitment rates and its quantification is essential for assessing the rate of recovery of this vulnerable species. The rate of neonatal mortality in the Pacific waters of Colombia has not yet been quantified.

While the current rate of mortality from human related activities (fishing gear or vessel strike) does not appear to seriously threaten this stock of humpback whales, it may slow its' population recovery. The susceptible status of this species and its affinity for near shore habitats increase concern. Collective effects of industrial development, resource exploitation and rapid increase in the whale watching industry could result in displacement and habitat degradation and impact on population numbers. Although the whale watching industry in Colombia was regulated in 1997, control exercised by local authorities is rather weak. Reasonable efforts to reduce the cause and rates of ship collision and entanglement must be developed to successfully minimise

their effects. The establishment of such measurements has been recommended world-wide (NMFS, 1991; Perrin et al., 1994).

This study indicates that incidental mortality and harassment of humpback whales in Colombia are a problem for their conservation. Management of fisheries, whale watching activities and ship traffic in specific areas must be addressed.

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